1 CHAPTER Properties of Materials

Q.1 Assertion (A): Buckling load of long columns made of mild steel and high tension steel are same for identical cross-section and end conditions.
Reason (R): All grades of steel have nearly equal Young's modulus.
(a) both A and R are true and R is the correct explanation of A
(b) both A and R are true but R is not a correct explanation of A
(c) A is true but R is false
(d) A is false but R is true

Q.2 Match List-I and List-II and select the correct answer using codes given below:

List-I
A. Wood
B. Concrete
C. Diamond

List-II
1. Homogeneous, allotropic
2. Homogeneous, orthotrotic
3. Heterogeneous, non-isotropic

Codes:

	A	B	C
(a)	1	2	3
(b)	1	3	2
(c)	2	3	1
(d)	3	2	1

Q.3 Assertion (A): Increase in carbon content of steel increases its brittleness.
Reason (R): Ultimate strength of steel increases with increase in carbon content.
(a) both A and R are true and R is the correct explanation of A
(b) both A and R are true but R is not a correct explanation of A
(c) A is true but R is false
(d) A is false but R is true

Q.4 Which of the following statements are correct?
1. Actual area of cross-section during loading is considered in engineering stress.
2. Within elastic limit, actual stress and engineering stress are nearly the same.
3. For practical purposes, actual stress is used within elastic limit.
(a) Only 1 (b) 2 and 3
(c) Only 2 (d) 1, 2 and 3

Q.5 Consider the following statements:
1. In ductile state, volume change does not occur in a metal.
2. For a perfectly plastic material, density remains constant with application of load.
Which of the above statement(s) is/are correct?
(a) Only 1 (b) 1 and 2
(c) Only 2 (d) None of these

Q.6 Match List-I with List-II and select the correct answer using the codes given below the lists:

List-I
A. Ratio of lateral strain to linear strain
B. Ratio of stress to strain
C. Ratio of extension to original length
D. Ratio of axial pull to area of section

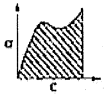
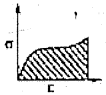
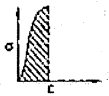
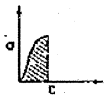
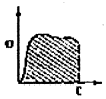
List-II
1. Strain
2. Poisson's ratio
3. Tensile stress
4. Young's modulus

Codes:

	A	B	C	D
(a)	4	2	3	1
(b)	4	2	1	3
(c)	2	4	3	1
(d)	2	4	1	3

Q.7 Match List-I (Material type) with List-II (Stress-strain curve) and select the correct answer using the codes given below the lists:

List-I
A. Soft and weak
B. Hard and brittle
C. Hard and strong
D. Soft and tough
E. Hard and tough

List-II
1. 
2. 
3. 
4. 
5. 

Codes:

	A	B	C	D	E
(a)	5	4	3	2	1
(b)	1	2	3	4	5
(c)	5	3	2	4	1
(d)	1	4	3	2	5

Q.8 Match List-I (Property) with List-II (Characteristic) and select the correct answer by using the codes given below the lists:

List-I
A. Fatigue
B. Creep
C. Plasticity
D. Endurance limit

List-II
1. Material continues to deform with time under sustained loading
2. Decreased resistance of material due to repeated reversals of stress
3. Material has a high probability of not failing under reversals of stress of magnitude below this level
4. Material continues to deform without much increase in stress.

Codes:

	A	B	C	D
(a)	2	1	4	3
(b)	2	1	3	4
(c)	1	2	4	3
(d)	1	2	3	4

Q.9 Which of the following are experimental stress analysis techniques?
1. Photoelasticity
2. Strain gauges
3. Moire fringe technique
Which of these statements are correct?
(a) both 1 and 2 (b) both 1 and 3
(c) both 2 and 3 (d) 1, 2 and 3

Q.10 Assertion (A): Strain is a fundamental behaviour of the material, while the stress is a derived concept.
Reason (R): Strain does not have a unit while the stress has a unit.
(a) both A and R are true and R is the correct explanation of A
(b) both A and R are true but R is not a correct explanation of A
(c) A is true but R is false
(d) A is false but R is true

Q.11 Which of the following is/are characteristics of a fatigue fracture?
1. Rough fracture surface
2. Rough and smooth areas on fracture surface
3. Plastic deformation
4. Concholdal markings on fracture surface
(a) 1, 3 and 4 (b) 2 and 4
(c) 2, 3 and 4 (d) 3 and 4

Q.12 For metals, creep becomes significant at temperatures of the order of
(a) 500°C
(b) half of melting point temperature on absolute scale
(c) melting point temperature on absolute scale
(d) any temperature

Q.13 Consider the following statements:
1. As time increases, rate of creep deformation decreases with time.
2. At any point in the steady state, the net strain has elastic and plastic strain components.
3. Creep results in progressive failure of the structure.

Which of the above statement(s) is/are correct?
(a) Only 2 (b) 1 and 3
(c) 2 and 3 (d) 1, 2 and 3

Q.14 Creep parameters help in
(a) avoiding creep testing
(b) establishing steady state creep rate in short time
(c) estimating permissible stress, temperature or time
(d) explaining creep mechanism

Q.15 Assertion (A): In compression test of mild steel, the engineering stress is greater than true stress in post elastic region.
Reason (R): In compression test, the cross-section area of the specimen increases.
(a) both A and R are true and R is the correct explanation of A
(b) both A and R are true but R is not a correct explanation of A
(c) A is true but R is false
(d) A is false but R is true

Q.16 Materials having elongation less than 5% are considered brittle. In such cases, factor of safety is based on
(a) yield stress
(b) endurance limit
(c) limit of proportionality
(d) ultimate stress

Q.17 During tensile testing of a specimen using a Universal Testing Machine, the parameters actually measured include
(a) true stress and true strain
(b) Poisson's ratio and Young's modulus
(c) engineering stress and engineering strain
(d) load and deflection

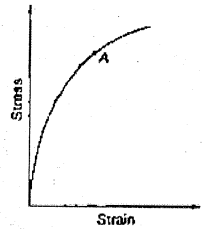
Q.18 In a tensile test, near the elastic limit zone
(a) tensile stress increases at a faster rate
(b) tensile stress decreases at a faster rate
(c) tensile stress increases in linear proportion to the strain
(d) tensile stress decreases in linear proportion to the strain

Q.19 Assertion (A): Rubber is a brittle material.
Reason (R): The post-elastic strain is negligible in rubber.
(a) both A and R are true and R is the correct explanation of A
(b) both A and R are true but R is not a correct explanation of A
(c) A is true but R is false
(d) A is false but R is true

Q.20 Consider the following statements:
1. Mild steel is more elastic than rubber.
2. Young's modulus of a material is used to represent the elasticity of the material.
3. Greater the Young's modulus, greater the elasticity.

Which of the above statement(s) is/are correct?
(a) Only 2 (b) 1 and 3
(c) 2 and 3 (d) 1, 2 and 3

Q.21



In the stress-strain curve shown above, the different modulii values are given as
Initial modulus = E_i
Secant modulus at $A = E_s$
Tangent modulus at $A = E_t$
Then
(a) $E_i > E_t > E_s$ (b) $E_i > E_s > E_t$
(c) $E_s > E_t > E_i$ (d) $E_t > E_i > E_s$

Q.22 Steel has its yield strength of 400 N/mm^2 and modulus of elasticity of 2×10^5 MPa. Assuming the material to obey Hooke's law up to yielding, what is its proof resilience?
(a) 0.8 N/mm^2 (b) 0.4 N/mm^2
(c) 0.6 N/mm^2 (d) 0.7 N/mm^2

Q.23 In stress-strain curve, the area upto elastic limit stress indicates which mechanical property?
(a) Ductility (b) Strength
(c) Resilience (d) None of these

Q.24 An axial residual compressive stress due to a manufacturing process is present on the outer surface of a rotating shaft subjected to bending. Under a given bending load, the fatigue life of the shaft in the presence of the residual compressive stress is
(a) Decreased
(b) Increased or decreased, depending on the external bending load
(c) Neither decreased nor increased
(d) Increased

Q.25 Assertion (A): Plastic deformation is a function of applied stress, temperature and strain rate.
Reason (R): Plastic deformation is accompanied by change in both the internal and external state of the material.
(a) both A and R are true and R is the correct explanation of A
(b) both A and R are true but R is not a correct explanation of A
(c) A is true but R is false
(d) A is false but R is true

Q.26 Consider the following statement:
For increasing the fatigue strength of welded joints, it is necessary to employ,
1. Grinding
2. Coating
3. Hammer peening

of these
(a) 1 and 2 are correct
(b) 1 and 3 are correct
(c) 2 and 3 are correct
(d) All are correct

Q.27 Assertion (A): Ductile materials generally absorb more impact loading than a brittle material.
Reason (R): Ductile materials generally have higher ultimate strength than brittle materials.
(a) both A and R are true and R is the correct explanation of A
(b) both A and R are true but R is not a correct explanation of A
(c) A is true but R is false
(d) A is false but R is true

Q.28 Assertion (A): Specimens for impact testing are never notched.
Reason (R): A notch introduces tri-axial tensile stresses which cause brittle fracture.
(a) both A and R are true and R is the correct explanation of A
(b) both A and R are true but R is not a correct explanation of A
(c) A is true but R is false
(d) A is false but R is true

Q.29 Which of the following materials generally exhibits a yield point?
(a) Cast iron
(b) Soft brass
(c) Annealed and hot rolled mild steel
(d) Cold rolled steel

Q.30 Assertion (A): For most brittle materials, the ultimate strength in compression is much larger than the ultimate strength in tension.
Reason (R): Many microscopic cracks, cavities and flaws are present in specimens used for testing.
(a) both A and R are true and R is the correct explanation of A
(b) both A and R are true but R is not a correct explanation of A
(c) A is true but R is false
(d) A is false but R is true

Q.31 Which of the following properties is more sensitive to increase in strain rate?
(a) Yield strength
(b) Elastic limit

(c) Proportional limit
(d) Tensile strength

Q.32 Match List-I with List-II and select the correct answer using the codes given below:

List-I (Property)
A. Tensile strength
B. Impact strength
C. Bending strength
D. Fatigue strength

List-II (Testing machine)
1. Rotating bending machine
2. 3 point loading machine
3. Universal testing machine
4. Izod testing machine

Codes:

	A	B	C	D
(a)	4	3	2	1
(b)	3	2	1	4
(c)	2	1	4	3
(d)	3	4	2	1

■■■■

Answers Properties of Materials

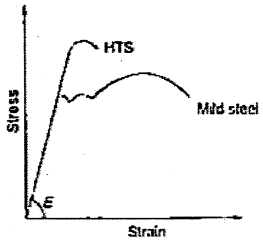
1. (a)	2. (b)	3. (b)	4. (b)	5. (c)	6. (d)	7. (a)	8. (a)	9. (d)	10. (b)
11. (c)	12. (b)	13. (b)	14. (c)	15. (a)	16. (c)	17. (d)	18. (c)	19. (a)	20. (d)
21. (c)	22. (b)	23. (c)	24. (d)	25. (b)	26. (c)	27. (c)	28. (d)	29. (b)	30. (a)
31. (b)	32. (d)								

Explanations Properties of Materials

1. (a)
By Euler's formula

$$P_{cr} = \frac{\pi^2 EI}{L_{eff}^2}$$

It means that buckling load depends only on 'E' for columns of identical cross-sections and end conditions.



Both mild steel and HTS has nearly the same slope for the stress-strain curve, i.e., same Young's modulus.

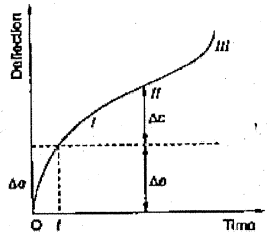
3. (b)
The increase in brittleness is due to the decrease in fracture strain with increase in carbon content of steel.

4. (b)
The original area before loading is considered in engineering or nominal stress, and actual area during loading is considered in true or actual stress. For practical purposes, engineering stress is used within elastic range.

5. (c)
A perfectly plastic material is incompressible, hence density remains constant with load application.
A metal in ductile state is considered to be in plastic state and volume does not change.

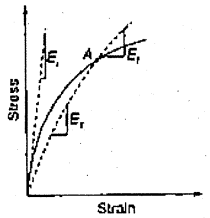
12. (b)
With increase of temperature, creep increases and becomes intolerable when temperature reaches to half of melting point temperature. Such a temperature is calle das homologous temperature.

13. (b)



Δe = elastic deformation
Δc = creep deformation
t = loading time
Stage-I: Rate of creep deformation decreases with time.
Stage-II: Constant rate of creep deformation steady state stage.
Stage-III: Rate of creep deformation increases with time.

21. (c)

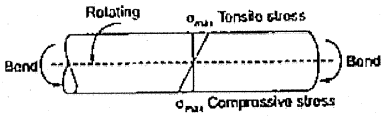


Thus, $E_i > E_s > E_t$

22. (b)
Proof resilience,

$$u_{max} = \frac{\sigma_y^2}{2E} = \frac{400^2}{2\times 2\times 10^5} = 0.4 \text{ N/mm}^2$$

24. (d)



When residual compressive stresses are induced on the outer surface, the magnitude of the tensile stress is reduced, thus contributing to increased fatigue life.

25. (b)
Following the elastic deformation, material undergoes plastic deformation.
It is also characterised by relation between stress and strain at constant strain rate and temperature.
Microscopically, it involves breaking atomic bonds, moving atoms, then restoration of bonds.
Crystalline solids deform by slip in particular directions.
Amosphous solids deform by viscous flow mechanism without any directionality.

26. (c)
A polished surface by grinding can take more number of cycles than a part with rough surface.
In hammer peening, residual compressive stress lowers the peak tensile stress.

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